

**A DEVICE FOR AXIAL STOPPING OF A ROTOR, IN PARTICULAR AN
ARMATURE OF AN ELECTRIC MOTOR, FOR BALANCING MACHINES.**

Field of the Invention

The invention relates to a device for axial stopping of a rotor. The device is
5 provided for balancing machines capable of detecting unbalances in rotors
occurring when the rotors themselves are driven in rotation.

The concerned rotors are preferably the armatures of electric motors used in
micromotors or electric tools, or the armatures of electric motors of small and big
household electrical appliances, electric motors employed in the automotive
10 sector, etc.

Description of the Prior Art

~~It is known that rotors of electric motors are mounted on support shafts defining
the rotation axis of said rotors and once mounted must be carefully measured
and balanced, in order to prevent vibrations and unbalanced stresses to be
15 generated in use, during rotation of said rotors, in many cases running with a
high number of revolutions per seconds.~~

The balancing machines carrying out measurement of these rotors or armatures
comprise elements intended for support and control of the radial loads, and axial-
abutment elements.

~~20 The elements intended for support and control of the radial loads, i.e. loads
directed in a direction perpendicular to the rotation axis, practically are generally
fork-shaped elements for support of said shafts which are connected to sensor
devices capable of detecting and measuring the amount of possible unbalances,
when a rotatory motion is imposed to the rotors.~~

~~25 The axial-abutment elements are on the contrary designed to abut against the~~

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5 ~~opposite end faces of the rotor shafts, to hold them in an axial direction, while the~~
rotatory motion necessary to detect and measure the unbalances to which the
same are subjected is being transmitted to them.

Practically in the known art the axial-abutment elements are generally made up
5 of a pair of elastic foils getting into contact, at their substantially flat portions, with
said end faces, against which they slide during the rotatory motion of the rotors.
It should be pointed out that in balancing machines the rotatory motion is
transmitted to the rotors through belts of a material having a high friction
coefficient which are in contact with the outer surface of the rotors themselves
10 when their support shafts are caused to rest on said fork-shaped support
elements.

To avoid occurrence of axial oscillations, during the rotor rotations, between the
abutment elements defined by said elastic foils, the rotor themselves are such
disposed that their rotation axis is not perfectly perpendicular to said rotation-
15 ~~controlling belts.~~

In fact a slightly inclined orientation of the rotors relative to said belts is generally
provided so that the belts may generate dragging forces on the rotors having a
small component directed towards one of the two axial-abutment elements.

Consequently, each rotor is pushed with a reduced force in one way alone of its
20 axial direction and only one of the two axial-abutment elements must react to the
action exerted by the corresponding end face of the shaft. The other axial-
abutment element exclusively performs a safety function, but practically is not
submitted to any stress.

In this manner, a good stability of the axial position of the rotors is obtained.

25 The known art briefly described above is satisfactory in many cases, but it has

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the drawback that sometimes it is not adapted to reach the highest reliability qualities required by the most severe standards concerning balancing machines. In particular, the requirement of a great precision is felt, in order to achieve repeatability and reliability in measures or "capability", in the cases in which for example it is provided that measures repeated a great number of times on the same rotor or armature might differ by ten per cent at the most from each other with respect to the proper tolerance value of the balancing machines which is already very small by itself.

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10 From checks of the experimental type it came out that unevennesses in the measurement results of rotor unbalances arise at least partly at the axial abutment elements used in the known art to axially retain rotors, and that unbalances depend on the finish degree of the ends of the rotor-supporting shafts.

In fact, the end faces of the rotor-supporting shafts have an unperfect perpendicularity relative to the rotation axis and this unperfect perpendicularity gives rise, on sliding against the axial-abutment elements i.e. the elastic foils, to additional vibrations that adversely affect the whole rotor thereby modifying detection from the balancing machines.

15 The above mentioned additional vibrations can also result from geometric and/or positioning defects of the support shafts on the axial-abutment elements.

Practically, it was found out that due to small imperfections at the axial-abutment elements, vibrations are generated that are interpreted as unbalance signals, which unbalances do not in fact exist.

In order to overcome the above mentioned drawback, a reduction in the perpendicularity error of the end faces of the rotor-supporting shafts cannot be in-

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~~any case envisaged, nor can be conceived raising of the working level of same.~~

In fact this technical solution would involve a heavy rise in the production costs of the rotors in a portion of same that is not of great importance as regards operation. In addition this technical solution would not enable complete

5 cancellation of the influence exerted by said vibrations on the unbalance

~~measure, due to contact of said end faces against the axial abutment elements.~~

Summary of the Invention

Under this situation the technical task underlying the invention is to conceive a device for axial stopping of rotor balancing machines capable of substantially
10 obviating the mentioned drawbacks.

~~Within the scope of this technical task, it is an important aim of the invention to~~
provide an axial-stopping device capable of preventing that, in measurements, other periodic unevennesses resulting from axial engagement of the support shaft should be added to unbalances typical of rotors.

15 Another important aim of the invention is to provide an axial-stopping device of simple structure, easy applicability to the already existing machines and reduced cost.

The technical task mentioned and the aims specified are achieved by a device for axial stopping of a rotor, in particular an armature of an electric motor, for
20 balancing machines, said rotor having a support shaft defining a rotation axis and two end faces transverse to said rotation axis, said device comprising at least one thrust unit having an abutment surface adjacent to one said end face and adapted to exert a repulsive force on said end face able to axially stop said support shaft and to keep an interstice between said abutment surface and said
25 ~~end face of said support shaft.~~

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Brief Description of the Drawings

5 ~~Description of a preferred embodiment of an axial-stopping device in accordance~~
with the invention is given hereinafter by way of non-limiting example, with the
aid of the accompanying drawings, in which:

- 5 - **Fig. 1** is a diagrammatic elevation front view of an apparatus provided with
a device in accordance with the invention;
 - **Fig. 2** is a plan view of Fig. 1; and
 - ~~**Fig. 3** is an enlarged side section of the axial-stopping device.~~

Description of the Preferred Embodiment

- 10 With reference to the drawings, the axial-stopping device in accordance with the
invention is generally identified by reference numeral **1**.

It is applied to a rotor-balancing machine, known by itself, denoted at **2**.

- 15 ~~The balancing machine is provided with a pair of substantially fork-shaped~~
support elements **3** on which a support shaft **4** of a rotor **5** is caused to rest; said
rotor may be an armature for an electric motor for example, the unbalances of
which within the admitted tolerances are wished to be measured and
subsequently reduced. Practically, the support elements **3** are oscillating and
connected to sensor devices capable of detecting the unbalance amounts in
order to carry out correction of said unbalances. The support shaft **4** defines a
20 rotation axis **4a** and terminally has two end faces **4b** substantially parallel to
each other and perpendicular to the rotation axis **4a**.

- The balancing machine **2** also comprises actuating means for carrying out the
rotatory motion of the rotor or armature **5**, which in Figs. 1 and 2 is embodied by
two driving belts **6** that are in contact with the outer surface of the armature when
25 ~~the related support shaft **4** is positioned on the support elements **3**.~~

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~~The driving belts 6 and therefore the dragging forces generated by said belts on~~
the armature 5 do not form a right angle relative to the rotation axis 4a but they
are slightly inclined to the plane perpendicular to said axis by a small angle β so
that they tend to push the armature 5 towards the stopping device 1 with a
5 reduced force.

At the opposite end from the one where the device 1 is located, preferably a
safety axial-abutment element 7 is provided, said element being of a known type
and at all events normally not designed to come into contact with the end face 4b
adjacent thereto.

- 10 The stopping device 1 is practically defined by a thrust unit having an abutment
surface 8 disposed in front of a corresponding end face 4b of the support shaft 4.
In an original manner, the thrust unit 1 is adapted to exert a repulsive force
capable of axially stopping the support shaft 4 in the vicinity of the abutment
surface 8 while keeping an interstice 1a between the latter and the end face 4b
15 close thereto, so as to avoid direct contacts therebetween.

The thrust unit 1 in fact comprises fluid-emitting means 9, the fluid being air,
water or oil.

- In particular, fluid 9 is defined by compressed air adapted to form a gap or a
cushion of air under pressure interposed between the abutment surface 8 and
20 the adjacent end face 4b of the support shaft 4.

Said air gap embodies the so-called repulsive force and constitutes an interstice
1a of some tenth of a millimeter sufficient to avoid direct contact between the
abutment surface 8 of the thrust unit 1 and the end face 4b of the shaft even if
the latter has surface unevennesses or perpendicularity errors relative to the
25 rotation axis.

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In more detail, the thrust unit 1 comprises an abutment element ~~10~~ made of a spring steel foil for example of a thickness in the order of one millimeter defining, on a first face thereof, the abutment surface 8 disposed in front of the end face 4b of the support shaft 4. At least one hole 11 is formed in the abutment element 10 and when the abutment element is made up of said foil, it consists of a through hole placed in the extension of the rotation axis 4a of shaft 4.

The fluid-emitting means 9 is embodied by an attachment sleeve 12 for a pipe 13 feeding air under pressure which is in engagement with a second face 14 of foil 10, at the through hole 11.

Also provided are attachment members 15 for the fluid-emitting means 9 made up of a threaded block 16 welded to foil 10 and with which sleeve 12 engages by screwing.

Based on tests carried out by the Applicant, the axial-stopping device 1 is able not only to stop the support shaft 4 of the armature 5 at a short distance from its abutment surface 8, but also to initially attract the shaft 4 itself not yet driven in rotation, towards said abutment surface.

In fact, a sort of sucking action takes place which is due to the weak negative pressure that, based on known hydrodynamics laws, is generated in the air flow coming out of the through hole 11 and forced to run in the gap included between the end face 4b of shaft 4 and the abutment surface 8 itself. Practically, the end face 4b of the support shaft is retained during rotation of the latter to a fixed and constant distance, thereby avoiding even minimum axial oscillations.

The invention achieves important advantages.

In fact, the axial-stopping device in accordance with the invention, by eliminating any contact between the end faces 4b of the rotor shaft 4 and solid surfaces,

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also enables the vibrations produced by said contact to be cancelled.

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Therefore, ~~unbalances typical of each rotor measured by the apparatus are not~~
at all affected by periodic unevennesses produced by axial stopping, as it
generally happens in the known art, and consequently they can be evaluated in a
5 more precise and reliable manner.

It will be finally recognized that the device in accordance with the invention can
be easily inserted in balancing machines of known type, so that by its use one or
both of the axial-abutment elements of the traditional type are replaced by it, in
particular the axial-abutment element against which the rotor to be balanced
10 tends to be pushed by the means controlling its rotation.

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The device can obviously be used for operation on rotors of any type when said
rotors are mounted on balancing machines. The repulsive force capable of
axially stopping the support shaft 4 and keeping an interstice 1a at the end face
4b can be embodied either by a fluid such as air, water or oil, or by a magnetic
15 element mounted on the abutment element 10, or by the abutment element itself
duly magnetized. In the last-mentioned case the support shaft 4 must be
magnetized as well at its end face 4b or said face must be associated with a
magnetic element of the same polarity as that of the abutment surface 8. The
identical polarities, by repelling themselves, balance the thrust exerted by the
20 means controlling rotation of the rotor.

A single thrust unit is generally provided at one end of shaft 4, since shaft 4 is
held in place by the means controlling its rotation. It is however possible for said
rotation-controlling means to have a neutral action, in which case a stabilizing
~~action on the shaft is exerted by another thrust unit.~~